NASA EARTH-SUN SCIENCE APPLIED SCIENCES PROGRAM

Ecological Forecasting Project on An Agent-Based Interface to Terrestrial Ecological Forecasting: ***Applications of Remote Sensing and Ecosystem Modeling for Protected Area Management***

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An opportunity exists to significantly increase the routine use of remote sensing data and ecosystem models within the National Park Service (NPS) Inventory and Monitoring (I&M) system for monitoring, forecasting, and scenario evaluation, particularly for parameters related to weather and climate, hydrology, vegetation, and fire. NASA remote sensing data, especially when combined with ecosystem models, provides an important capability for continuous park-wide monitoring of critical ecosystem conditions. The goal of this project is to use the Terrestrial Observation and Prediction System (TOPS) at NASA Ames Research Center to integrate a suite of automated monitoring and forecasting data and information products into the I&M system to assist the NPS in management of U.S. National Parks.

Work conducted under this project will leverage TOPS capabilities for automated data delivery to integrate thirty different TOPS data products derived from NASA sensors and ecosystem models into the I&M system. These TOPS products will provide a new capability for continuous monitoring of park-wide ecosystem conditions. TOPS will be used to reliably deliver nowcasts and forecasts at resolutions ranging from 30 m to 1 km. TOPS will also be used to facilitate on-demand retrieval of high-resolution satellite imagery to aid in monitoring of areas of special significance within the park. Finally, ecosystem models within TOPS will provide an important capability for simulation and scenario evaluation to aid NPS staff in the development of long-term management plans for park resources (e.g., the Tuolomne Corridor Management Plan in Yosemite National Park).

Current project efforts are focused on the development of a prototype system for Yosemite National Park and the Sierra Nevada I&M Network (SIEN) that can be easily adapted for use in other parks and integrated with other I&M networks. The prototype system will be comprised of four components and will focus on the integration of data from NASA satellites and ecosystem models to provide information on vegetation patterns and change, hydrologic patterns, and wildfire. Integration of these products with the I&M SIEN will provide new capabilities for monitoring and modeling of ecosystem conditions within parks to provide advance warning of potential threats to park ecosystems. The components of the prototype system will include:

1) Continuous, near real-time, park-wide monitoring of ecosystem conditions at a minimum resolution of 1-km;
2) Short-term forecasting of a suite of parameters related to ecosystem function through the integration of NASA remote sensing data and ecosystem models;

3) On-demand acquisition and delivery of high-resolution satellite data for periodic monitoring of critical habitats or events within a park; and
4) Implementation of hydrologic and ecosystem models to facilitate high resolution model runs for evaluation of the impacts of alternate management scenarios on hydrologic and vegetation patterns in the park.

Upon completion, the prototype system will provide data and information to support NPS scientists and staff in identifying trends and events, and making decisions related to the following issues in Yosemite National Park:

- Detection of major disturbance events;
- Ecosystem water balance monitoring;
- Runoff monitoring and flood prediction;
- Monitoring and modeling of sensitive areas in parks: riparian corridors, restoration sites, campsites, backcountry;
- Vegetation monitoring to aid in invasive species detection;
- Fire occurrence and fire risk monitoring;
- Detection and prediction of landcover change, and the predicted impact of climate change on vegetation, fire, and hydrologic patterns in the park;
- Modeling of impacts of park infrastructure placement on ecosystem function; and
- Nitrogen deposition modeling and water quality monitoring.

Work to date has focused on the first stage of implementation of the prototype system, which involves the delivery of daily and 8-day average, park-wide, 1-km resolution data products from TOPS for Yosemite National Park and a buffer area surrounding the park. Products developed to date include the following:

MODIS (8 day products)
LAI / FPAR
GPP / NPP
LST
NDVI /EVI
Landcover (Annual)
Snow
Fire

Meteorology (Daily)
Maximum Temperature
Minimum Temperature
Rainfall
Solar Radiation
Vapor Pressure Deficit

TOPS Ecosystem (Daily)
Soil Moisture
Evapotranspiration
Outflow
GPP / NPP

Future plans include extension of a subset of these products to include forecasts of these parameters with lead times ranging from 5 to 180 days. These forecasts of ecosystem conditions will give park managers advance warning of potential changes in ecosystem conditions, providing time to consider adjustment to current management strategies and funding levels for different management activities. In addition, we will initiate a set of high-resolution modeling runs and acquire high-resolution satellite imagery for key areas of interest to the park managers to verify the utility of these data products for monitoring of sensitive areas within the park such as riparian zones, camp sites, areas impacted by invasive species or fire, or areas where anomalies in conditions have been detected in the coarser resolution data. Upon completion of the prototype system, we will initiate efforts to implement similar systems in Sequoia-Kings Canyon and other U.S. National Parks.